Gamification within plant health in the Forestry Commission

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This note is the outcome of a scoping project commissioned by the Forestry Commission (FC) and carried out by the University of Stirling and the FC. The aim was to raise understanding of "gamification" among staff in the FC and associated bodies, identify possible applications of gamification to tree health issues and suggest possible ways forward in this area. The note incorporates feedback and ideas from a workshop hosted as part of this project in February 2015. The key purpose of this note is to encourage readers to identify possible areas for gamification in the FC and to put forward their ideas for potential games. The project complements a similar project undertaken by the Food and Environment Research Agency (Fera), the University of Stirling, and the University of York during October 2014 – March 2015. The Fera project is larger in scope, as it covers *plant* health more widely rather than focusing on *tree* health as presented here.

This note adopts the following structure:

- It begins with a short overview of gamification, its relationship with behavioural economics and the key tree health issues faced by the FC.
- Then moves on to the key discussion points raised at the February workshop (see annex 1 for the attendees list) are explored; covering the potential role of gamification, possible approaches for putting gamification into practice, and methods for evaluating its success.
- Followed by a discussion of how gamification could be taken forward by the FC. This includes possible case-study applications and the results of a gamification in plant health competition at the University of Stirling,
- The note rounds off with a list of current actions that the FC is involved with.

1. What is gamification?

Gamification can be broadly defined as the application of game-like thinking and mechanics to "serious" purposes, rather than outright entertainment. Games, especially video-games, are very popular: according to a recent study by the Internet Advertising Bureau[1], 7 out of 10 Britons played some form of video game in the previous six months, and the average Briton spends six hours per week playing games. Game players are diverse: they span all age groups, and more than half are female, with women aged 25-44 forming the largest group. Gamification provides a way of capitalising on the popularity of games to achieve other desired objectives. Gamification itself can be applied in many different forms, including electronically or as a physical game. Electronic games cover a further spectrum of opportunities, from complex simulations to simple-to-use apps (a type of program typically run on a smartphone or tablet).

There are many different ways of using games for serious purposes:

- A common form is the use of game elements such as competition (or cooperation), goals and challenges, progress up levels, prizes and rewards, for the purpose of increasing customer engagement with a product, or motivating staff. Games of this type must be carefully designed to appeal to users, and may suffer from a decline in interest once the initial novelty has faded. A case

[1] www.iabuk.net/research/library/gaming-revolution

in point is the FourSquare social networking app, which had game features that were very popular when introduced, but have now been discontinued[2].

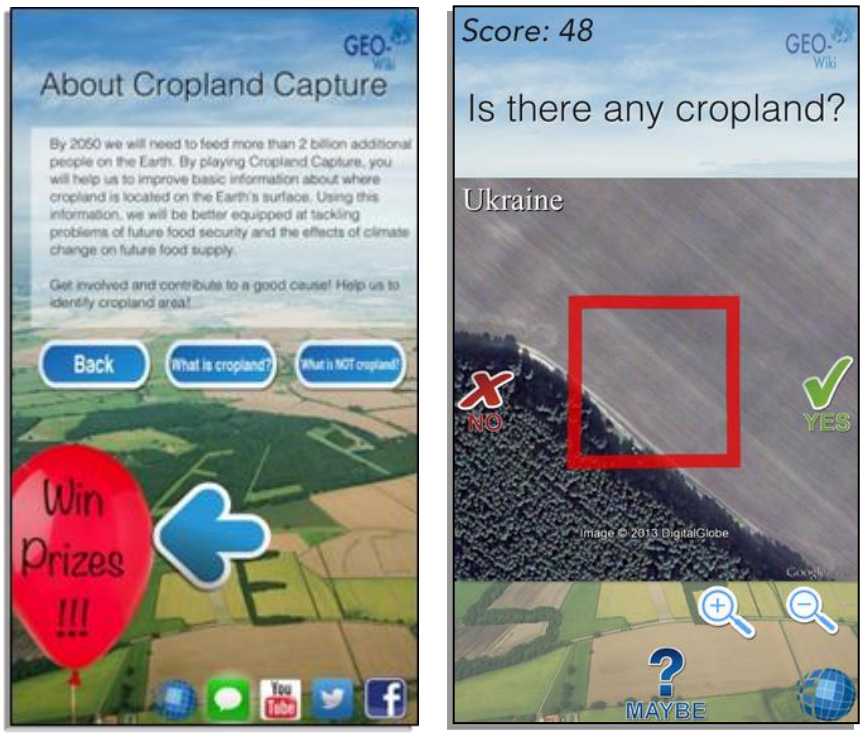
- Games may be incorporated into the environment to promote desired behaviours. Examples include a "Speed Camera Lottery"[3] in Stockholm, in which non-speeding drivers won prizes funded by the fines collected from speeders; and recycling bins[4] in Istanbul which dispense food for stray animals when a bottle is recycled.

Source: www.thefuntheory.com, copyright Volkswagen 2009

- Games involving highly detailed, realistic simulations, often called "serious games"[5], are often used for education and training. For example, in military, healthcare, and disaster management domains. They are also used by expert decision-makers to explore possible future scenarios and discover the consequences of different policy choices. This type of game is usually played by committed users during a training session or workshop, so there is less need for an emphasis on fun and more need for realistic simulations with accurate parameters. Typically this requires detailed inputs from experts, adding another layer of complexity.

[2] www.researchthroughgaming.com/gaming/foursquares-gamification-goes-awry/
[3] www.thefuntheory.com
[4] www.pugedon.com
[5] See, for example, games listed at www.seriousgamesdirectory.com

- Another type of game utilises the computational ability of humans by getting them to play enjoyable games that have an underlying serious function. This way of using games may be called "crowd sourcing", "human computation", or "citizen science". Examples include games like FoldIt[6] (protein folding), Fraxinus[7] (gene sequencing) and Cropland Capture[8] (image capturing), which exploits the superior image-processing ability of human players by asking them to identify areas of cropland in satellite images of the world.



Source: Image copyright www.geo-wiki.org

- Games can be used for scientific research, particularly in experiments to investigate human behaviour in situations that cannot practically be recreated in the real world. Such "virtual experiments" have been used in areas such as epidemiology, environmental economics, and psychology. Like "serious games", virtual experiments rely on computer simulations to represent the real world. There are limitations to such virtual experiments however, especially when any results or lessons learnt are transferred to other situations. Within economics, such games, in the form of virtual experiments, could play a key role in determining people's preferences for different environmental outcomes.

- Finally, games may be used as an effective form of outreach and public engagement. Examples relevant to tree health and forestry include a tree disease management simulation from the University of Cambridge called webidemics[9] and Slug Trumps[10], a simple, paper-based slug identification game developed for a Nuffield Foundation research project. In the US, the Society of

[6] www.fold.it
[7] www.facebook.com/fraxinusgame
[8] www.geo-wiki.org/games/croplandcapture/
[9] www.webidemics.com
[10] www.slugwatch.co.uk

American Foresters[11] provides a collection of online and paper-based games for teaching children about forestry issues. The US Department of Agriculture also hosts a game where the player must freeze and collect Asian Longhorn Beetles in order to stop their spread[12]. Each round of the game is interspersed with information and questions about the pest which helps raise awareness.

It is clear from the above that there are a range of options as to how gamification can be applied within different situations. Gamification can also be thought of as a tool for bringing interdisciplinary teams together to present a coherent and clear message. For example, creating a model of the spread of an invasive pest, this could involve natural scientists to model the spread, and economists and geographers to model the impact. Then, computer scientists could amalgamate these different models into one so that communication teams can more readily engage with the public.

2. Behavioural economics

A key aim of behavioural economics is to bridge the divide between traditional economics and real world observations of people's behaviour. This arises due to economics assuming that people act rationally. This in turn requires that people know all there is to know about a choice to be made and subsequently choose the best choice. However, in the real world this is often not the case.

There have been many studies researching this area which have suggested an array of different methods that could be used to try and correct for people not always selecting the best option, either for themselves and/or for society at large. One of these methods is to "nudge" people towards the best choice or outcome, be it for the individual (such as wearing a seatbelt) or society (such as taking public transport). A "nudge" has been defined as a "way of influencing people's choices without limiting the options, or appreciably altering their relative costs" (Moseley et al, 2014). An often cited example of "nudging" is simply changing a choice from an opt-in to an opt-out.

It may be possible to employ gamification as an effective instrument to subtly disseminate information and attempt to change behaviours. Thereby, "nudging" people to do socially desirable actions, like cleaning their footwear before leaving infected forest sites. A more developed application could include gamification providing a platform for different stakeholders, like neighbouring landmanagers, to come together and see what effects their actions have on each other. This could provide insights into group dynamics and "nudge" people towards more socially desirable outcomes.

A framework for applying behavioural economics, developed by the Behavioural Insights Team in partnership with the Cabinet Office, goes by the acronym EAST (Service et al, 2015). This stands for:

- **E**asy – reducing the effort barrier for actions;
- **A**ttractive – getting people's attention;
- **S**ocial – get people to spread the message;
- **T**imely – engage people when they care most.

[11] www.safnet.org/education/forestryfun.cfm
[12] www.asianlonghornedbeetle.com/wp-content/themes/beetlebusters/game.html

These principles could provide a useful framework to applying gamification and in considering how gamification could be used to help "nudge" people to certain actions. Gamification elements would typically fall under the (**A**) attractive section, by providing incentives to change behaviour as with Stockholm's speed camera lottery. Though, the whole framework could be a useful guide to gamification, such as keeping it simple, incentivising change, tapping into people networks and delivering the message when it matters most.

3. Overview of tree health

This section gives a brief overview of tree health in the UK. This includes typical pest and disease pathways into the UK, the main pests and diseases currently, and the key gamification-related considerations that arise from this from a FC tree health perspective.

The threat of invasive pests and diseases has been present for many years, with a number of high profile examples such as Dutch Elm disease in the 1970s, *Dendroctonus micans* in the 1980s, and *Phytophthora ramorum* and Ash dieback in the 2010s. Many invasive pests and diseases can cause significant damage when outside their natural range as there may not be any natural control to their spread. There are several key drivers for such incidences occurring. For instance, increased global trade has been attributed with a rise in invasive pests and diseases, either through the trade in live plant material or via other timber and wood packaging material. Further, climate change may induce pests and diseases to spread from their typical native range.

Some of the principal pests and diseases currently posing a threat to UK woodlands include:

- *Ash dieback* – is a fungus that infects ash trees causing leaf loss, and is normally fatal to the tree, though older trees may survive for many years following infection. This disease is now widespread throughout the UK.

- *Oak processionary moth (OPM)* – the caterpillars feed on oak tree leaves, leading to defoliation but unlikely to lead to tree death. The toxic hairs on the caterpillar pose a public health hazard, causing rashes and possible respiratory problems. The current policy is to eradicate OPM where it is found outside of the core containment zone in west London.

- *Phytophthora ramorum* – is a fungus-like disease which infects a number of plants and trees (principally Japanese larch) and generally causes tree mortality. It was first found to be infecting trees in 2009 and is widespread among western areas of the UK. The current policy is to contain this disease.

- *Asian Longhorn Beetle* – is a pest which poses a threat to a range of broadleaved trees, typically leading to tree death. There has been one outbreak in Kent, which is under eradication, and believed to have originated from wood packaging material. The current policy is to eradicate this pest if found.

There are also a number of threats that are not known to be present in the wider environment in the UK such as:

- *Emerald Ash Borer* – is a beetle that can cause significant damage to ash trees, typically leading to ash tree death following one or two years of infection.

- *Pine processionary moth* – feed on pine tree needles, possibly leading to defoliation but unlikely to lead to tree death. Like OPM, they can pose a public health hazard to humans.

It is clear that there are a number of significant pests and diseases that are either already in the UK or have the potential to enter. Hence, it is crucial that the FC can facilitate the best possible response to this threat. In light of the above, there are several key considerations through which gamification could impact on tree health:

1. *Awareness and reporting the presence of pests and diseases* – amongst landowners, foresters and the general public for instance and the varying levels of this awareness.

2. *Conflicting interests and need for cooperation* – again, between and within the groups above.

3. *Knowing what the different options are and look like* – the need to clearly communicate the impact of different options and the need for a recommended course of action.

It is proposed in this note that gamification can be an important part of the suite of solutions that are required for an effective tree health delivery system. These key considerations should be kept in mind when applying gamification to tree health.

More information on tree pests and diseases can be found on the FC website here.

4. Views from the workshop

Using the tree health considerations listed above as impetus a workshop on applying gamification to tree health in the FC was held in February 2015. This workshop solicited views from the attendees from several organisations, including the FC, Forest Research, and Scottish Government (see annex 1). Attendees heard presentations on gamification and behavioural economics, followed by a discussion about potential uses of gamification within their own areas of work. This section covers the needs that were identified by the attendees and others, the desired approach and finishes with some thoughts about what success would look like.

4.1 Needs

One potential role of gamification is for informing and educating industry in order to change behaviour, for example, with respect to tree health practices. Industry represents a relatively small, well-informed, potentially captive audience. At the other end of the scale, games could be developed for the general public to raise awareness of biosecurity risks, to encourage environmentally responsible behaviour, to promote or enhance the recreational uses of woodland, to involve the public in monitoring woodland conditions (citizen science), or to raise the general level of awareness of the work done by the FC. Here follows a more detailed list of the potential uses for gamification identified during the discussion:

1. **Providing information to industry:** Attendees generally agreed that increasing woodland diversity is a positive in terms of tree health. This is based upon the idea that a more disparate species composition will reduce the overall tree health risk One way of influencing landowners and wider industry to undertake this is through simulation based "serious" games. These could be used in a workshop setting with stakeholders to explore what the optimal species mixes would be and the implications of these. This could be an effective communication tool that leads to increased cooperation and consensus. It should be noted that this would be a fairly specialist form of "game"/simulation due to the small audience.

2. **Promoting awareness of tree health issues and good practice:** The discussion group identified a need to raise awareness of tree health issues both among the public and among landowners, managers, investors, and other stakeholders. Gamification can be a means to communicate this as well as increasing public support for different and more resilient woodland structures which may require public funding incentives. This can also provide information on people's preferences for different woodland settings. Another goal is to raise awareness of biosecurity within a woodland setting. Forest resilience is interlinked with trading activities: trade in seeds, wood products and live trees can lead to the introduction of new pests and disease. Games and visual simulations can be used to illustrate these problems and communicate them to decision-makers and the public. A key challenge here is to sustain interest in the product, as some pests and diseases may take years before their presence is known.

3. **Recreational use of woodland:** A third possible role for gamification is to promote and enhance the use of woodland for recreation. Websites of relevant bodies such as National Parks UK could include games to engage and educate children and other users and encourage visits to parks. Games can also be provided onsite at parks to educate visitors and enhance their experience. This can in turn help highlight the importance of protecting woodlands.

4. **Encouraging responsible behaviour in woodland environments:** Gamification can be used to encourage visitors to woodland to behave responsibly, for example, by not littering, using recycling bins, and complying with rules regarding fire safety. From a tree health perspective, gamification can encourage behavioural change such as staying on designated footpaths, not removing material from infested sites and cleaning footwear and bicycles after visiting a woodland.

5. **Monitoring woodland conditions:** Games can be used as a way to enlist members of the public to monitor and report on the conditions of parks and woodlands, for example by checking for signs of disease, or spotting pests or other significant species. The FC's Tree Alert app is an example of this. One drawback of this approach is that it requires expert resources to respond to reports and ascertain the validity of findings.

6. **Outreach**: Games can be used as a way of showcasing the work done by the FC and making it more widely known to the general public. This could be done

through targeted initiatives with the cooperation of schools, nurseries or the Horticultural Trade Association.

4.2 Approaches

One of the key points that emerged in the discussion was the necessity for games to be kept simple. There was a strong consensus on this across presenters and participants. A key question relating to this was whether it would be better to have a large, integrated project across the FC, or to carry out small, separate projects.

Consensus also emerged that different audiences would be better targeted by different types of games. Games aimed at landowners and investors could take the form of "serious games", using realistic simulations. For these games, it is important to have accurately parameterized simulation models, and this may require scientific research. It may be possible to use existing data held by the FC, for example ForesterGIS data, or production forecasts. Gamification could be used as a way of visualising these data and its real-world interpretation, and could provide engaging ways of interacting with the data to explore what-if scenarios. If possible, game development costs could be reduced by building upon existing open-source (where the code is made freely available) games rather than developing new ones. Exploring combined farm and forestry management could be an interesting and topical theme for a game.

Games aimed at the general public, who are a "non-captive" audience, should be fun and engaging and should be carefully designed to appeal to the demographic groups most likely to play them. Different types of games may need to be developed, depending on whether the target audience is schoolchildren, young male gamers, middle-aged female gamers, or the typical spread of forest visitors.

Games for enhancing recreational use of parks and woodland could be traditional games such as treasure hunts and bug/species spotting challenges, or could be more technically sophisticated. For example, one can imagine giving park visitors a smartphone app which detects when it is close to a Bluetooth (a type of wireless technology) beacon placed on a tree, and responds by providing information about the tree species or presenting the user with a relevant mini-game to play. This could also be an effective means of communicating tree health issues in a local area.

The citizen science approach to gamification has already been attempted with the TreeAlert app, which lets users submit photos of trees that appear to be diseased. One insight from this project is that in designing such games it is crucial to take into account the key “responses” and how these (including any data) will be collected and analysed. If human experts are required to analyse all the data, for example by verifying pictures, the cost could be prohibitively expensive.

4.3 Evaluation

One of the final issues raised was how to measure success, and what success would look like. This is hard to assess. It may be possible to count the number of downloads of online games, the number of times games are played, the number of unique players, etc., but measuring the impacts and any signs of behavioural change will be much harder. For games with committed, "captive" players, such as serious games aimed at industry stakeholders, it may be possible to use before and after

questionnaires to gauge whether game play has had the desired effect. For casual games, it may be necessary to rely on indirect measures, for example, looking at whether the introduction of a game on a park website is associated with an increase in the number of visitors to the park. Behavioural change outcomes will typically need such indirect, or proxy, measures, such as attempting to link the use of a specific game with a change in visitor type behaviour at a specific site.

5. Pathways to gamification

At present, the FC is only just beginning to explore the possibilities of using gamification. Although this scoping project and workshop have begun to raise awareness of gamification among FC staff, there is still uncertainty about what is possible, where gamification could be applied, the costs entailed, and how to go about doing it. In this section of the note several examples of what gamification in tree health could look like are presented, as well as some routes forward and current activities taking place as a direct result of the Fera and FC gamification scoping projects.

5.1 Examples

This section briefly puts forward four suggested applications of gamification under various genres and aims. This is to highlight the range of applications and solicit further ideas from readers.

Tree Health E-Learning (e-learning)
Gamify the FC's tree health e-learning tool in appropriate places. This can be done by adding scoring mechanisms (even a quiz with a leaderboard of users) or achievements (such as taking and uploading pictures of various diseased trees). Could get "points" for adding insights or experiences gained in order to share with others, or allow others to comment on thoughts.

Target Audience: FC staff, or professionals in the tree health area
Aim: Make the learning about tree health more fun and more engaging
Evaluation: Number of users; incorporate a feedback mechanism;

ALERT! (citizen science)
This could be a dual purpose program, by mixing the dissemination of information to the public in order to encourage the public to engage and feedback any gathered information. A small wireless sensor could be placed in high risk areas where outbreaks are known which alerts people who approach the vicinity via their mobile phones to keep alert and to take precautionary measures. This would be especially suitable for a pest like oak processionary moth which has a potential human health impact and is often located in recreational areas. This alert could then link to a program whereby users can send in pictures of suspected oak processionary moth or even just say whether any signs of it were seen or not.

Target Audience: Users of infested woodlands
Aim: Disseminate and gather information on pest
Evaluation: Users opening link; feedback given

Tree Defence: Can You Fend the Pests Off? (casual game)
This game could portray critical information about the different pathways that a tree pest could take to infect a UK woodland. A "tower defence" game is a popular type of a real-time strategy video game where the goal is to prevent an enemy from reaching a specific point (typically progressing through a maze) through the construction of various towers which repulse the enemy. This general set up could be applied to a tree health scenario, whereby the "map" is a top down representation of a typical landscape, for example, with a healthy forest (the target), a town, transport links and a port for instance. The "enemies" are a variety of pest carrying entities, such as wood packaging at the port, exotic planting in gardens, visitors with infested soil on their shoes, and so on. Then, the "towers" are a variety of defences that can be set up to protect the woodland within a fixed budget, such as intercepting infected shipments and visitors.

Target audience: General public
Aim: To raise awareness of the pathways that tree pests can take
Evaluation: Number of downloads; visits to a linked website for more information.

Bio-economic Modelling of the Impact of Asian Longhorn Beetle (simulation)
This could be an example of a more serious game, but that still retains gamification elements rather than pure biological or economic modelling. The gamified element here, being a clearer, easy-to-use interface, and the ability to play out different scenarios amongst a group of users – i.e. multiplayer capability. Such a simulation could then be used to bring non-expert land managers together and play out an ALB outbreak increase understanding and hone an optimal control strategy. A model of the spread of the disease can then be played out, with land managers being able to undertake various control actions to minimise the impact, with "points" being the number of trees not infected or felled for instance. The interactive component could be used to reinforce the importance of cooperation. Such an approach could also be used to collect insightful information on how land managers would react to an external threat and how they cooperate.

Target Audience: Land managers
Aim: Raise understanding and identify optimal control policies
Evaluation: Response success to future/similar pest outbreaks

Woodland capture (citizen science)
Similar to the "Cropland Capture" example discussed in section 1. Whilst, it is thought that accurately identifying larch from aerial photography may be too difficult for untrained people, there may be scope for people to help identify broad woodland types. Such as private coniferous, mixed, broadleaved or no trees. Volunteers could then be allocated random aerial photography images and asked to identify the broad type of woodland. This would then complement the FC's knowledge and databases, and allow more targeted approaches to be undertaken. To encourage participation it is vital that a tangible and useful benefit is identified and portrayed, though prizes and various achievements could also be awarded after a determined amount of square kilometres completed.

Target Audience: General public
Aim: Utilise people's recognition abilities to complement the FC's data
Evaluation: "Plays"; data outputs; input level into FC operations

5.2 Suggested approach

To take gamification further, the next stage could be to carry out one or more small pilot projects. These would allow FC staff to learn more about what the game development process involves and to see concrete examples of what is achievable. These might then inspire more ambitious ideas and lead on to larger projects.

For low-cost pilot projects, a fruitful approach could be to work in partnership with university Computer Science or Informatics departments. Undergraduate students must usually carry out a major software development project in their final year and are on the lookout for interesting project ideas. A gamification project for an external "customer", such as the FC, will appeal to many students. A well-motivated and competent undergraduate Computer Science student is capable of creating a fully-working game during the course of a two-semester or one-year project.

There are a number of benefits to using undergraduate student projects for pilot studies. The cost can be kept low, as student and academic supervisors will not normally require to be paid by the external "customer". The content of the project can be malleable, and does not need to be rigidly specified at the outset. This gives scope for projects that are exploratory, and whose final form evolves over time through discussions among the "customer", the academic supervisor, and the student.

There are also clear downsides to reliance on student projects. The quality of the final product depends very much upon the calibre of the student, and cannot be guaranteed. Also, and crucially, after students graduate and leave the university they may no longer be available for making corrections, updating, or otherwise maintaining software developed for projects. Therefore, it is likely that further incentives will be needed to maintain the software, or to pay for someone else to do so. Guidance provision could also be included in the project – though, this would likely be as an extra.

To pursue the student project approach, the first step would be for interested members of FC staff to make contact with Computer Science lecturers. Appropriate lecturers would be those who have an interest in computer game development or who are responsible for coordinating final-year projects. It would be useful for the FC staff member to have some idea at this stage of the intended purpose and audience for the game (educating schoolchildren? Communicating issues to the general public?), and of any resources (e.g. models or datasets) that they can provide. If the project goes forward, the FC staff member should expect to be involved with shaping and giving feedback on the project. Typically, this would entail at least three meetings with the student, usually at the beginning, interim, and final stages of the project.

Larger scale gamification projects could be carried out in a number of ways: in-house within the FC; through partnership with a university; or through a professional game development company. University partnerships can be explored through services such as Interface[13], which promotes collaboration between businesses and higher education and research institutions. There are many game development companies in the UK, including some that specialize in gamification and serious games[14].

[13] www.interface-online.org.uk

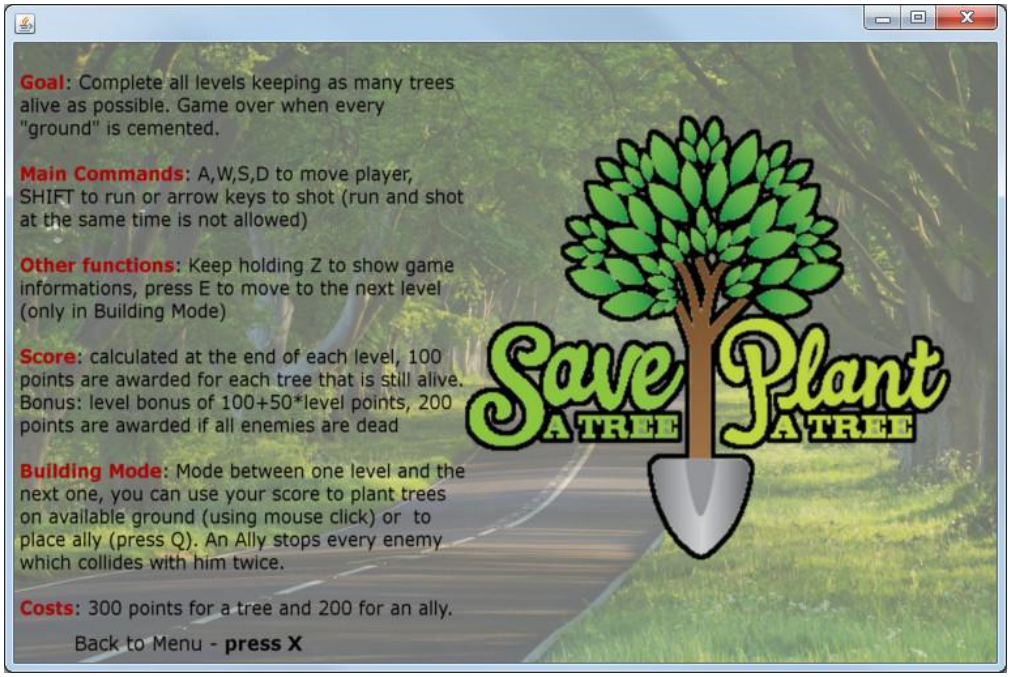
[14] One example is PlayGen (www.playgen.com).

5.3 Gamification for Tree Health competition

A competition on "Gamification for Tree Health" was organised for Computing Science students at the University of Stirling during April 2015. This is tied to a third-year course on computer game development, and the prizes are funded by Fera and the FC. This section describes three entries to this competition and shows the potential for what gamification can achieve even in a limited time period and with limited resources. The games centre on the casual "for fun" end of the gamification spectrum, and have been judged upon the following criteria: fun; novelty; relevance to tree health; and educational potential. The source of the following information and images is the University of Stirling.

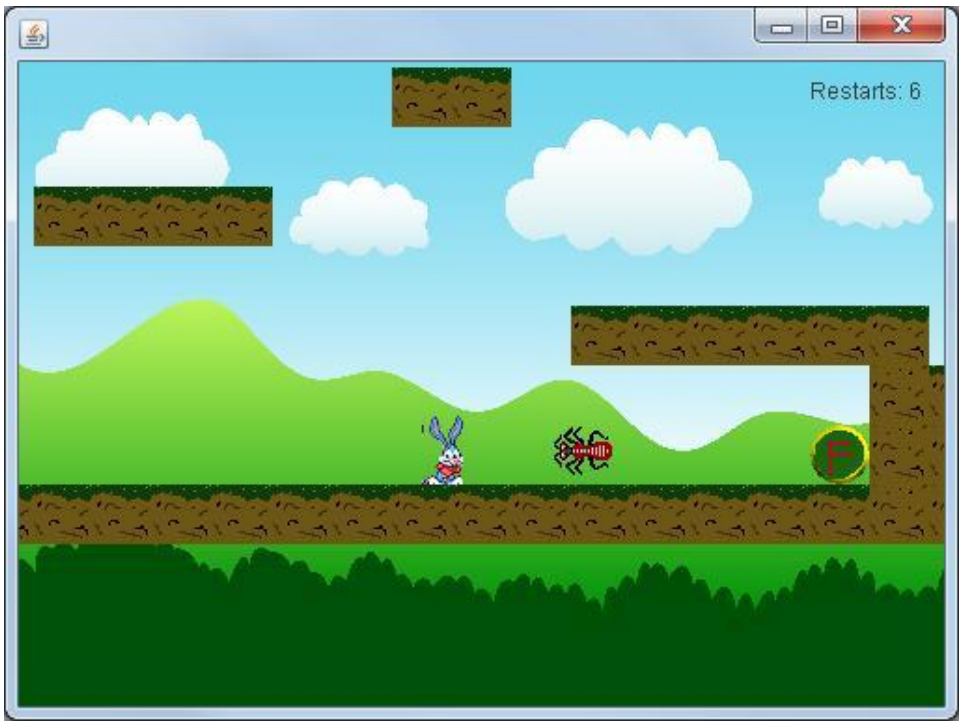
***A. Save a Tree/Plant a Tree* - Giacomo Iadarola, University of Stirling**

This is a top-down game, in which the player moves about a landscape protecting trees by shooting down enemies armed with axes who try to cut the trees down. Players can accumulate points and use these to plant more trees. As a piece of software, the game works very well. In terms of gamification for plant health, the game could be used as a 'casual game' providing entertainment with a theme of protecting forests and planting trees. Perhaps with a slightly less violent method for protecting trees would be an improvement!



***b. Protect the Plant* - David Evans, University of Stirling**

This is a platform game in which a bunny character must collect water, seeds, and fertilizer to grow a plant, while dodging enemy ants. There is a catchy musical theme during play. The software works well, but there are a few minor issues such as imperfect collision detection. In terms of gamification for plant health, this could be an entertaining 'casual game' with some educational content for children. The idea of providing plants with their basic needs and avoiding pests could be extended, perhaps by introducing different game levels with different species that have different needs, a broader range of pests, and perhaps educational inserts explaining what different plants needs and how the pests attack them.



***C. Tree Diversity Simulator* - Craig Docherty, University of Stirling**

This is a relatively complex game which is unfinished in its implementation. It is a top-down game in which the player can purchase and plant trees. The game design is relatively complex, and the implementation is unfinished. The finished product was planned to include disease, diversity of trees in their susceptibility to disease, and economic transactions between the player and other game characters.

5.4 Current actions

We end with a list of activities currently taking place at the FC, Fera, and the University of Stirling, all of which are direct outcomes of the Fera and FC gamification scoping projects.

- A final year Computing Science project titled "Exploring forest planning and climate change with a 'serious game'" will be carried out at the University of Stirling during 2015-16, in partnership with Forest Research. The project will develop a 'serious game' that is built on top of models of climate change provided by Forest Research.

- A summer undergraduate internship, sponsored by Fera and co-supervised by Fera and the University of Stirling, will look at "Gamification with Virtual Reality for Urban Tree Management". The project will develop immersive, three-dimensional visualizations of scenarios involving urban tree health and management, using computer-generated imagery and real video footage. The internship project will be extended and further developed after the summer as a final year project. Local Authorities would be a key audience to this type of project and could be extended to promoting other messages, such as increasing urban tree cover and ascertaining current data and knowledge gaps.

- The FC tree health team are currently developing an e-learning suite for tree health practitioners. This is intended to provide an easy to use portal for the latest information on a variety of tree health issues. Monitoring the uptake and

usage of this could provide an insight into what role users would like from such a product as well as indicate any scope for gamification within this.

- The FC is currently exploring various next steps for this work area, including the feasibility of incorporating into wider research programmes and in particular with modelling and mapping experts.

5.5 Summary

In summary, gamification is an exciting area whose possibilities have barely been touched within tree health agencies in the UK. We hope that this report will help to raise awareness and inspire interest, leading to gamification projects which promote engagement, education, and good communication among experts and the public about the vital issues of forestry and tree health.

If you are interested in further information in this area or have any suggestions for possible gamification applications then please get in touch with either Peter Greene or Savi Maharaj at: **peter.greene@forestry.gsi.gov.uk** or **sma@cs.stir.ac.uk**, respectively**.**

Annex 1: Workshop Attendees

Please see the following list for the attendees to the gamification in plant health workshop hosted by the FC on the 26th of February 2015:

Ben Jones, Plant Health Operations Manager, Forestry Commission England

Craig Docherty, Computing Science student, University of Stirling

John Morgan, Head of Plant Health, Forestry Commission

Liz Poulsom, Plant Health, Forestry Commission

Nick Mainprize, Deputy Head of Plant Health, Forestry Commission

Pat Snowdon, Head of Economics and Climate Change, Forestry Commission

Paul Munro, Press Officer, Forestry Commission Scotland

Peter Greene, Economist, Forestry Commission

Richard Eden, HMU Inspectorate, Scottish Government

Richard Haw, Economist, Forestry Commission

Romy Strachan, Plant Health Policy, Scottish Government

Savi Maharaj, Computing Science Lecturer, University of Stirling

Stephen Bathgate, Modeller, Forest Research

Yvonne Hay, Plant Health Policy, Scottish Government

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